EEDP-01-30
May 1993

# *Environmental Effects of Dredging* *Technical Notes*

## Environmental Effects Evaluation for Thalweg Disposal of Dredged Material

### Purpose

This technical note describes the general concept of thalweg disposal and presents information on the potential environmental effects of thalweg disposal, including water quality, habitat alteration, and fate of sediments. This note also presents the results of studies done on the environmental consequences of thalweg disposal at four test sites on the upper Mississippi River.

### Background

The thalweg of a river is defined by a line whose course is given by connecting the lowest points along the streambed for each transect. The thalweg's course passes through pools at river bends and through crossings between the bends. During high-discharge events along a river system, pool areas scour and crossings accrete material. The opposite takes place during low-discharge periods, but with a lower magnitude of change. Blockages to navigation generally occur at the crossings.

The concept of thalweg disposal is to dredge the shallow reaches and dispose the dredged material in a downstream pool. Thalweg disposal is a form of open-water disposal and is regulated under Section 404 of the Clean Water Act (CWA). The "Guidelines for Specification of Disposal Sites for Dredged or Fill Material," outlined in 40 CFR 230, apply (U.S. Environmental Protection Agency (EPA) 1980).

## Additional Information

Contact the author of this technical note, Ms. Trudy J. Olin, (601) 634-2125, Dr. Andrew C. Miller, (601) 634-2141, Dr. Michael R. Palermo, (601) 634-3753, or the manager of the Environmental Effects of Dredging Programs, Dr. Robert M. Engler, (601) 634-3624.

## Concept of Thalweg Disposal

Thalweg disposal refers to the practice of disposing of dredged material by discharge into the naturally occurring scour holes within a river—a form of open-water disposal specific to these locations. A more rigorous description has been given by the U.S. Army Engineer District (USAED), Rock Island, as follows: "Thalweg disposal is placement of dredged material in a deep-water portion of the channel thalweg where it will become a natural element of the sediment transport system, and will be assimilated into the system with minimal impacts to either the sediment transport system or the environment" (Nanda and Baker 1984). In practice, thalweg disposal mimics a cut-and-fill operation, whereby a shallow crossing is dredged and the material is moved into a downstream pool. Thalweg disposal is therefore similar to the natural process of low-water scour and accretion of crossings and pools, although greater in rate and magnitude. Theoretically, if the volume to be dredged is small compared with the total annual transport, the energy increment used to move the sediment from crossing to pool should have little overall effect on the regime of the river (Lagasse 1975).

By definition, the thalweg of a river follows the line connecting the lowest points along a streambed. The thalweg will meander back and forth across the riverbed in response to the changing course of the river, as shown in Figures 1 and 2. At many locations within the thalweg, the depth is sufficient to permit dredged material disposal without interference to navigation. Figure 3 illustrates this concept, before and after disposal.

Thalweg disposal has been proposed as a disposal alternative for uncontaminated sediments and as an alternative to the use of sidecasting dredges, which have the disadvantage of high disturbance and a tendency for redeposition of material in the cut. Thalweg disposal offers potential economic advantages, eliminating the need to transport dredged material to confined disposal sites, and the costs associated with acquisition, development, and maintenance of those sites. In some cases, thalweg disposal constitutes the environmentally preferred alternative (personal communication, January 1993, Richard M. Baker, USAED, Rock Island).

Information on the implementation of thalweg disposal is provided in *Environmental Effects of Dredging Technical Notes* EEDP-01-31, "Implementation Approach for Thalweg Disposal of Dredged Material" (Olin 1993).

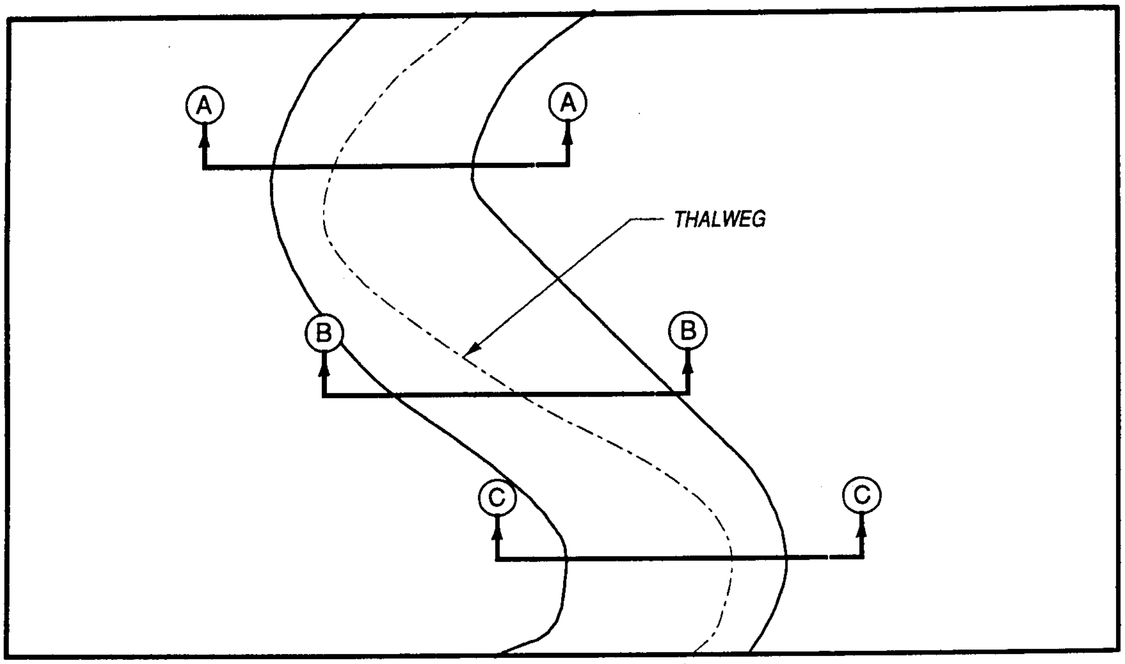


**Figure 1. Line of the thalweg**

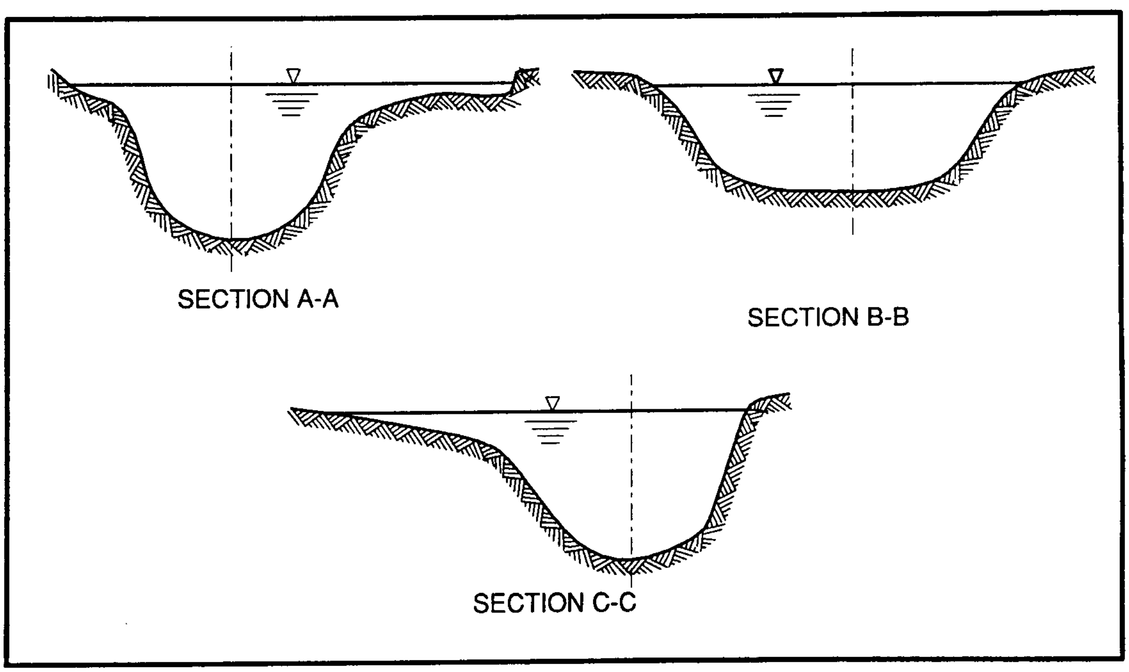


**Figure 2. Section depicting location of the thalweg**

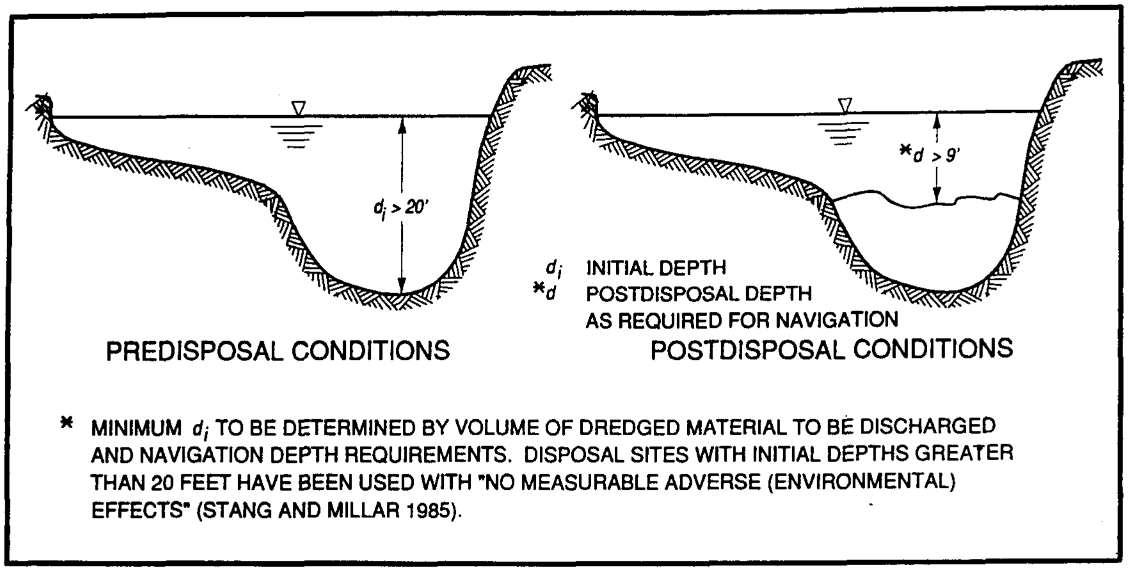


**Figure 3. Section view of disposal site**

## Environmental Effects

Potential environmental concerns of thalweg disposal include the effect on water quality (due to increased turbidity and resuspension of any contaminants), habitat alteration (due to changes in the existing substrate), and the fate of sediments.

Environmental consequences of thalweg disposal were studied at four test sites on the upper Mississippi River (Paddock and McCown 1984, McCown and Paddock 1985). The USAED, Rock Island, has supported studies to demonstrate the viability of thalweg disposal for noncontaminated dredged material (McCown, Paddock, and Ditmars 1984, Paddock and McCown 1984, and McCown and Paddock 1985). In addition, studies were conducted to determine the relative value of various habitats within the riverine system in order to establish environmentally sound criteria for implementation of the procedure (Lubinski 1984, Stang and Nickum 1985b).

### Water Quality Effects

Because thalweg disposal is a form of open-water disposal, the suitability of the material for open-water disposal from the standpoint of contaminants must be determined. A tiered evaluation approach is used (Environmental Protection Agency/U.S. Army Corps of Engineers (EPA/USACE) 1991; EPA/USACE, in preparation).

An initial screening for contamination is designed to determine, based on available information, if the sediments to be dredged contain any contaminants in forms and concentrations likely to cause unacceptable impacts to the environment. Materials considered for thalweg disposal may be excluded from testing as specified in 40 CFR 230.60. However, if the material does not meet the exclusions, the contaminants must be addressed with respect to their potential for biological effects or release through applicable pathways.

Water column contaminant impacts must be considered from the standpoint of water quality (chemical) and toxicity (biological). Benthic impacts must be considered from the standpoint of toxicity and bioaccumulation. Detailed descriptions of the initial screening for contamination and testing and of the assessments for the tiered approach are available in EPA/USACE (1991) and EPA/USACE (in preparation).

Turbidity and suspended solids in the water column will be increased to some degree during thalweg disposal, with the degree of the effect depending upon the disposal method. Typically, dissipation occurs rapidly after disposal, and the effects are transient. However, the acceptability of a discharge is regulated under State water quality certification requirements and Section 404 of the CWA (EPA 1980).

**Habitat Alteration**

Possibly the most significant effects of aquatic disposal are seen as a result of burial of the benthos. Some species are capable of migrating upward through the imposed sediment load, but most surface-dwelling life forms cannot, and therefore die. Mussels, periphyton, invertebrates, and dormant fish populations can suffer mortality. Effects on larval fish are thought to be minor, as they are not bottom-dependent for food or shelter (Stang and Millar 1985).

The effects of thalweg disposal are not altogether permanent. Reestablishment of species on the disposal site begins within several months, and near-complete recovery is achieved within 1 to 2 years (USACE 1983). Usually, opportunistic species are the first to repopulate a disposal site. Species diversity at the site is low, often for several months; however, diversity can recover over a period of years.

From the perspective of the ecosystem as a whole, it is desirable to protect species diversity, as well as species with identified recreation and ecological value or endangered species. Because of the potential for adverse effects of thalweg disposal on the benthos, it is important to adhere to responsible site selection procedures, with an important objective being to avoid valuable habitats both within and near the intended disposal site.

Aquatic biota will differ from location to location, as will their habitat. Because of the dynamic nature of the riverine environment, generalizations are somewhat difficult to make, but some features emerge as consistently important to a wide variety of aquatic life forms. Substrate type is one such feature, with coarse and stable substrates being important to a wide variety of fish species for egg laying and protection from high-velocity water. Typically, these substrates consist of hard sand and clay with mixtures of gravel, cobbles, bedrock, shells, and boulders or logpiles (Lubinski 1984).

Sand substrate and sand dunes in a dynamic environment are of less value to species on the upper Mississippi, although this may not be true in other locales. Deep holes have been demonstrated to be important to catfish for overwintering, and catfish have been found in the deep scour holes located in outside bends on the upper Mississippi (Stang and Nickum 1985a). However, this habitat is generally considered less valuable because of the high water velocities found there. It has been demonstrated that where revetments, dike fields, weirs, and other hydraulic or natural "structures" exist, catch per unit effort and species numbers tend to be higher (Stang and Nickum 1985b). Studies in other locales would reveal other species and associated habitats of importance.

Preservation of species diversity and endangered species is regulated by the Endangered Species Act of 1978, as amended. While general characteristics of valuable aquatic habitat are known, the annual and seasonal variability in the use of any site by the aquatic community would indicate a need for examination of the proposed disposal site and its immediate area (which may be potentially affected by disposal) prior to use. This may be accomplished by sampling, diving surveys, and other methods that will provide a rapid assessment of substrate and the organisms present (personal communication, 16 September 1992, Dr. Andrew C. Miller, U.S. Army Engineer Waterways Experiment Station).

Effective sampling can be accomplished to varying degrees of reliability, and may not be feasible in all cases. Therefore, to further minimize the potential for adverse effects, thalweg disposal should be

- Restricted to those sites constituting the least valuable habitat to species of importance.
- Restricted to disposal of materials of similar grain size to those of the disposal site (personal communication, January 1993, Richard M. Baker, USAED, Rock Island).
- Seasonally restricted as appropriate for local conditions and habitat uses.

### Fate of Sediments

Lubinski (1984) suggested that, after placement in the thalweg, dredged material either remained at the site or was assimilated into the bed load, where it could then migrate in response to water currents.

Migration of sediment is an important environmental consideration, which can potentially impact important habitats downstream from the disposal site.

Thalweg disposal has been used to some extent on the lower Mississippi River, and the Rock Island District has used and studied the procedure on the upper Mississippi River. Lower Mississippi dustpan dredging operations use the procedure when the river stage is such that access to holes downstream from the extraction site is possible. While there may be some movement of sediment out of the disposal site, in this area it constitutes a small fraction of the bed load, and effects are considered to be negligible (personal communication, August 1992, Larry Rabalais, USAE Division, Lower Mississippi Valley).

Studies of the movement of sand, tagged with fluorescent dye, from four test sites on the upper Mississippi River (Savannah Bay, Whitney Island, Gordons' Ferry, and Duck Creek) were conducted by the Argonne National Laboratory. Results of a 9-month observation of the Savannah Bay site (Paddock and McCown 1984) correlated closely with results obtained at the Whitney Island and Gordons' Ferry sites. This investigation revealed that contours of the disposal mound had been altered and dunes had developed, similar to the original bottom configuration of the river. Movement of tagged sand from the original site was observed, apparently confined to within the thalweg, and occurred in response to high river discharge.

At the Gordon's Ferry site, sampling that was conducted after a 5-year flood event (at a time approximately 20 months after disposal) revealed downstream movement of tagged sand for a distance of approximately 1,000 m.

Tagged material redistributed outside the thalweg was thought to be primarily fines and not representative of the characteristics of typical dredged material. It was concluded that "virtually no movement of dredged material into side channels occurs where the thalweg is at least 10 to 20 feet deeper than the channel inlet. Where the side channel inlet and the thalweg are of similar depth, however, migration of material into the side channel can be assumed. Side channel accretion may be due to sand input from the channel border area" (personal communication, January 1993, Richard M. Baker, USAED, Rock Island).

In the sites tested and sampled, the disposal mounds were eradicated by the first flood. Tagged sand appeared to have been incorporated into the bed forms of the natural channel (Ditmars, McCown, and Paddock 1986). A similar experiment conducted in a more complex reach with submerged wing dams on either bank resulted in a return to original depth within 5 months (September to January) after disposal (Ditmars, McCown, and Paddock 1986). Further monitoring of other, more diverse sites will be necessary to determine whether the behavior of these sites is representative.

As part of investigations conducted at Waterways Experiment Station for the St. Louis District, two tests in a physical movable-bed model were conducted for the Dogtooth Bend reach of the middle Mississippi River (miles 39.6 to 20.2). Considerable channel stabilization work has been done at this location, including weirs, dikes, and revetments, all designed to increase channel depth and improve navigation. The model used granulated coal as both dredged material and bed medium. Plastic particles were mixed with the dredged material to act as tracers. One test examined disposal along the opposite bank from the dredge cut and in scour holes off the ends of dikes. True thalweg disposal was not examined. Sediment transport, rate of movement, and areas of deposition were examined and recorded. Preliminary results were encouraging in that, for the limited testing performed, material deposited in the scour holes at the stream end of dikes did not negatively impact the navigation channel in the two bends and crossing downstream of the disposal site. However, a more intensive study would be needed to determine if results were representative of the behavior of sediments in natural channels.

## Summary

"Thalweg disposal is placement of dredged material in a deep-water portion of the channel thalweg where it will become a natural element of the sediment transport system" (Nanda and Baker 1984). Thalweg disposal mimics the natural low-water scour and accretion of crossings and pools.

Of primary concern are the potential adverse effects on water quality due to increased suspended solids, possible resuspension of contaminants, short- and long-term effects on the aquatic environment from alteration of the existing habitat, and effects on the immediate area resulting from sediment migration from the disposal site. The environmental effects of thalweg disposal are minimized, however, when the procedure is appropriately implemented and the disposal site appropriately located. In some cases, thalweg disposal may be the environmentally preferred alternative.

## References

Ditmars, J. D., McCown, D. L., and Paddock, R. A. 1986. "Movement of Dredged Sand at Thalweg Disposal Sites," *Proceedings of the Fourth Federal Interagency Sedimentation Conference*, Vol 2, Las Vegas, NV.

Lagasse, P. F. 1975. "Interaction of River Hydraulics and Morphology with Riverine Dredging Operations," Ph.D. dissertation, Colorado State University, Fort Collins, CO.

Lubinski, K. S. 1984. "Winter Diving Surveys of Main Channel Microhabitats and Fish Populations in Mississippi River Reaches Subjected to Thalweg Disposal," Aquatic Biology Technical Report 1984 (13), Illinois Natural History Survey, Grafton, IL.

McCown, D. L., and Paddock, R. A. 1985. "Movement of Tagged Dredged Sand at Thalweg Disposal Sites in the Upper Mississippi River," ANL/EES-TM-270, Vol 3, Argonne National Laboratory, Argonne, IL.

McCown, D. L., Paddock, R. A., and Ditmars, J. D. 1984. "Movement of Tagged Dredged Sand at Thalweg Disposal Sites in the Upper Mississippi River," ANL/EES-TM-270, Vol 1, Argonne National Laboratory, Argonne, IL.

Nanda, S. K., and Baker, R. M. 1984. "Experience in Channel Maintenance in Upper Mississippi River," *River Meandering, Proceedings of the Conference Rivers '83*, American Society of Civil Engineers, New York.

Olin, T. J. 1993. "Implementation Approach for Thalweg Disposal of Dredged Material," *Environmental Effects of Dredging Technical Notes* EEDP-01-31, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Paddock, R. A., and McCown, D. L. 1984. "Movement of Tagged Dredged Sand at Thalweg Disposal Sites in the Upper Mississippi River," ANL/EES-TM-270, Vol 2, Argonne National Laboratory, Argonne, IL.

Stang, D. L., and Millar, J. G. 1985. "Evaluation of Environmental Impacts of Thalweg Disposal of Dredged Material," prepared for U.S. Army Engineer District, Rock Island, Rock Island, IL.

Stang, D. L., and Nickum, J. G. 1985a. "Radio Tracking of Catfish and Buffalo in Pool 13, Upper Mississippi River," prepared for Fish and Wildlife Interagency Committee and U.S. Army Engineer District, Rock Island, Rock Island, IL.

____________. 1985b. "Review of Information Concerning Sheltered Microhabitats in Large River Systems," prepared for Fish and Wildlife Interagency Committee and U.S. Fish and Wildlife Service, Rock Island, IL.

U.S. Army Corps of Engineers. 1983. "Dredging and Dredged Material Disposal," Engineer Manual 1110-2-5025, Washington, DC.

U.S. Environmental Protection Agency. 1980 (24 Dec). "Guidelines for Specification of Disposal Sites for Dredged or Fill Material," Part IV, Vol 45, No. 249, Washington, DC.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 1991. "Evaluation of Dredged Material Proposed for Ocean Disposal; Testing Manual," EPA-503/8-91/001, Washington, DC.

____________. "Evaluation of Dredged Material Proposed for Discharge in Inland and Near-Coastal Waters; Inland Testing Manual" (in preparation).

## Bibliography

Baker, Richard M., McCown, Donald L., Paddock, Robert A., and Ditmars, John D. 1984. "Thalweg Disposal: Demonstration of an Alternative," *Dredging and Dredged Material Disposal*, Vol 2, Proceedings of the Conference Dredging '84, American Society of Civil Engineers, New York.

Chen, K. Y., and others. 1976. "Chemical Constituent Migration Study Completed; Dredged Material Research," Miscellaneous Paper D-76-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Fulk, R., Gruber, D., and Wullschleger, R. 1975. "Laboratory Study of the Release of Pesticide Materials to the Water Column During Dredging and Disposal Operations; Dredged Material Research," Miscellaneous Paper D-75-10, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Johnson, B. H. 1974. "Investigation of Mathematical Models for the Physical Fate Prediction of Dredged Material," Technical Report D-74-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

McCollum, R. A. 1988. "Blountstown Reach, Apalachicola River Movable-Bed Model Study," Technical Report HL-88-17, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Solomon, R. C., Johnson, J. H., Bingham, C. R., and Colbert, B. K. 1974. "Physical, Biological, and Chemical Inventory and Analysis of Selected Dredged and Disposal Sites, Middle Mississippi River," Miscellaneous Paper Y-74-6, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Vann, R. G. 1982. "O&M Dredging Experience as Related to Channel Deepening for Coal Ports" (Abstract), *Proceedings of a Seminar on Attaining Water Quality Goals Through Water Management Procedures*, U.S. Army Corps of Engineers Committee on Water Quality, Washington, DC.